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(71) Applicant
Usui Kokusai Sangyo Kabushiki Kaisha

(Incorporated in Japan)

131-2 Nagasawa, Shimizu-cho, Sunto-gun, Shizuoka-ken 411, Japan

(72) Inventor
Yuzo Hitachi

(74) Agent and/or Address for Service
Brewer & Son
Quality House, Quality Court, Chancery Lane, London, WC2A 1HT

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B1F
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C23C B01J F01N

(54) A method of manufacturing a metallic carrier base material for supporting a catalyst for exhaust gas purification

(57) A method of manufacturing a metallic carrier base material of multi-layer structure, if desired accommodated in a case and as illustrated in Fig. 3, for supporting a catalyst for exhaust gas purification wherein a multi-layer body is formed by compiling alternately, planar material and corrugated material so as to be in contact with each other, each made of thin nickel-plated steel strips, whereby vent holes are formed between the planar material and the corrugated material, if desired, after inserting the multi-layer body into a cylindrical case, and treating the multi-layer body by immersion in molten aluminium. The multi-layer body may be wound up in a spiral form or piled up in stratified form. A contact portion may be formed between the planar band material and the corrugated band material which is bonded by spot welding. The nickel-plated steel strips may be made of low carbon steel or chrome steel. The thickness of the strip may be 0.30 to 0.1 mm. The immersion may be performed at 700-800°C within a period of about 60 seconds.

FIG. 3

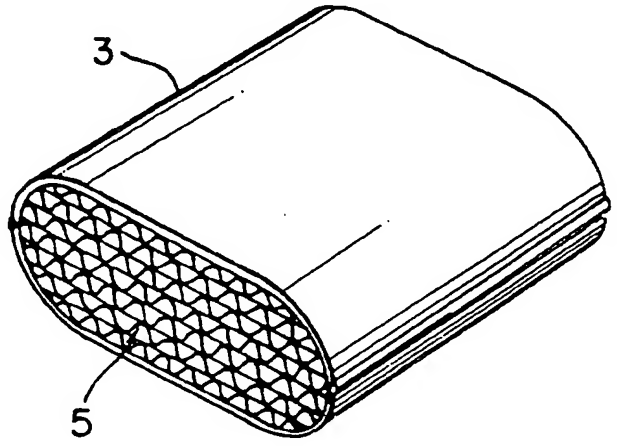

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FIG. 1

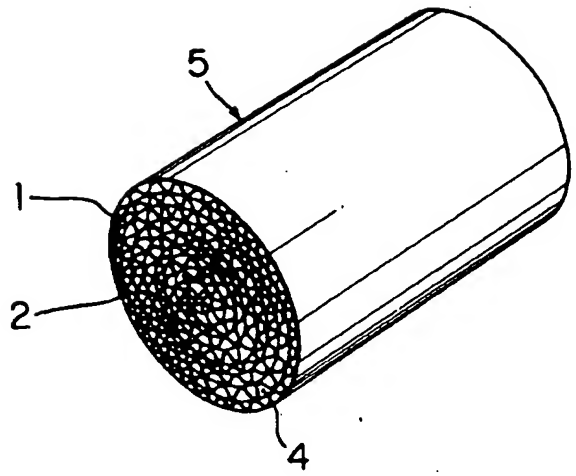

FIG. 2

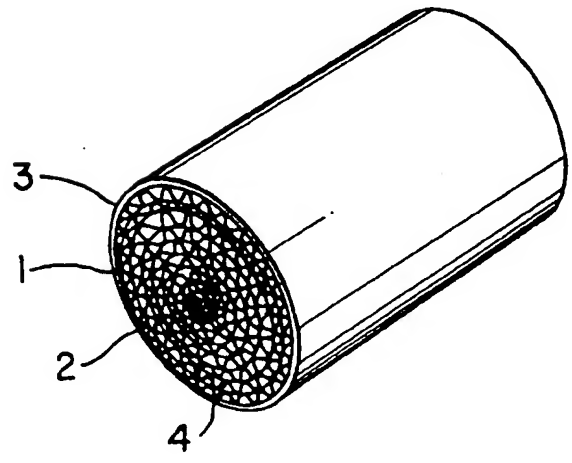

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FIG. 3

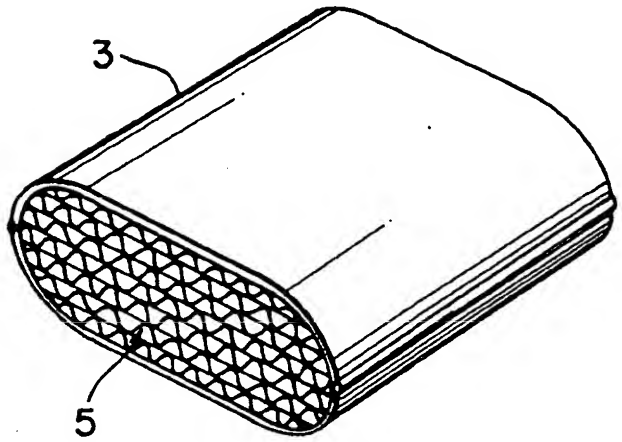
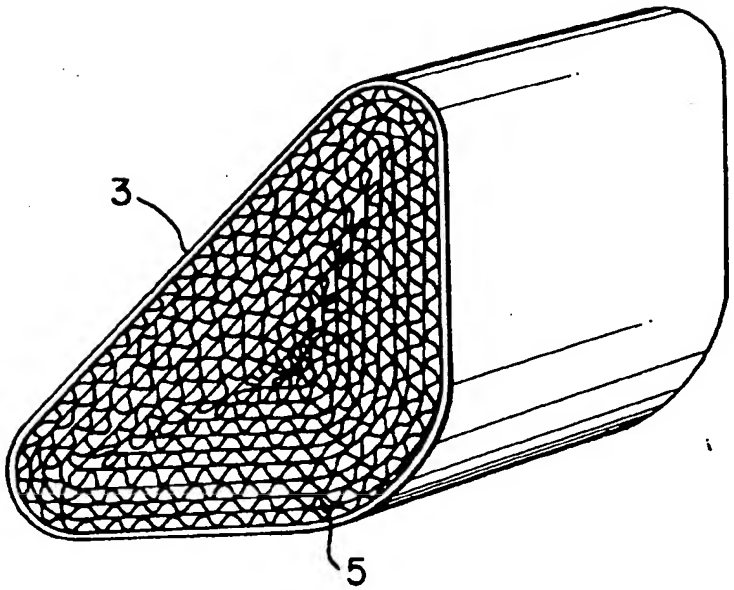


FIG. 4



A METHOD OF MANUFACTURING A METALLIC CARRIER BASE MATERIAL FOR SUPPORTING A CATALYST FOR EXHAUST GAS PURIFICATION

The present invention relates to a metallic carrier base material for supporting a catalyst for exhaust gas purification to be used generally by mounting it in the middle of an exhaust gas pipe as a means to purify exhaust gas of automobiles. Here, the "carrier base material" differs from the "carrier" as used in the field of chemistry, it means an implement used to maintain the catalyst supported by the carrier.

In order to enlarge the carrier area per unit volume, i.e. to enlarge the effective contact area between the exhaust gas and the exhaust gas purification catalyst per unit volume, and to ensure the lightweight design for the metallic carrier base material itself. The metallic carrier base material for supporting a catalyst for exhaust gas purification has conventionally consisted of a multi-layer body of spiral or stratified (i.e. layers on top of one another) form with a number of screen-like vent holes for passing exhaust gas in a certain direction. Planar band materials and corrugated band materials, made of very thin heat-resistant steel strips of less than 0.1 mm in thickness, are piled up alternately to furnish a contact portion. The metallic carrier base material, composed of such multi-layer body material, is accommodated in a metal case with open ends when necessary. The bonding between the band materials themselves in the contact portion of the multi-layer body, or between the band material and the metal case, is performed by brazing, after the formation of the

multi-layer body by electron beam welding or laser welding. This is described in the Japanese Provisional Patent Publications No. 54-13462, No. 57-1585, No. 56-4373, etc., or by treating the band materials in advance with the brazing material of powdery or foil types.

As with the above-mentioned heat-resistant steel strip, for example, heat-resistant steel of chromium-aluminium-ferrite type, containing chromium of 15-25 weight % and aluminium of 2-5 weight % is used. However, the steel strip of this type is not very easily rolled, and the material cost is expensive, because it is necessary to pass it repeatedly through the process of rolling and annealing, until the thin material of the desired thickness, suitable for carrier base material, is obtained.

On the other hand, conventional electron beam welding, or laser welding, requires special and expensive devices in the assembling and bonding of the multi-layer body. It is necessary to perform troublesome and complicated operations such as spot welding at points or portions of contact in confined spaces or in internal areas, and this results in lower productivity.

In the bonding method by brazing, special care has to be taken on the type and arrangement of brazing material or on the heating condition.

The object of the present invention is to form a metallic carrier base material by using a specific steel strip for easier rolling such as thin strip material, to reduce the

production cost of such thin materials, and to make a metallic carrier base material for supporting a catalyst for exhaust gas purification, whereby firm bonding is assured between the multi-layer band materials themselves, and between the band material and the case, each having heat-resistant properties and resistance to high temperature corrosion, so that detachment or displacement of components may not occur due to vibration during operation.

In describing the advantageous features of the present invention, the invention relates to the method to manufacture a metallic carrier base material, of the multi-layer body, to maintain the catalyst for exhaust gas purification. A multi-layer body with a number of screen-like vent holes in axial direction, is formed by alternatively piling up the planar band material and the corrugated band material, made of thin steel strips treated with nickel plating in advance, to furnish the contact portion, and then by treating the multi-layer body, by immersing it into the molten aluminium bath.

The invention also relates to the method to manufacture a metallic carrier base material to maintain the catalyst for exhaust gas purification, by the use of a multi-layer body. The multi-layer body having a number of screen-like vent holes in axial direction is formed by alternately piling up the planar band materials and the corrugated band materials made of thin steel strips treated with nickel plating in advance, to furnish the contact portion, and by immersing it into the molten

aluminium bath after the multi-layer body is accommodated in a cylindrical metal case.

The above-mentioned objects and advantages of the present invention will be more clearly understood when considered in conjunction with the accompanying drawings.

Fig. 1 is a perspective view of the metallic carrier base material of multi-layer structure according to an embodiment of this invention, and Fig. 2 represents a perspective view of the metallic carrier base material of Fig. 1, when it is housed in a metal case. Fig. 3 is a perspective view of the metallic carrier base material of multi-layer structure, according to another embodiment of the invention when it is housed in a metal case. Fig. 4 shows a perspective view of the metallic carrier base material of multi-layer structure according to still another embodiment of the invention, when it is housed in a metal case, whose cross-section has the form of a triangle.

The structure of the metallic carrier base material according to this invention will be explained in conjunction with the drawings.

The multi-layer structure as seen in Fig. 1 and Fig. 2 is wound up in spiral form, whereas the multi-layer structure in Fig. 3 is piled up in stratified form.

In general, the catalytic converter for automotive exhaust gas is mounted in the underfloor tunnel of an automobile. Such an underfloor tunnel is usually shaped in the form of a triangle or a trapezoid to reduce the

protuberance of the floor in the compartment, and the case with triangular form as shown in Fig. 4 is well suited to the complicated shape of such a tunnel. Consequently, it is possible in such a case to effectively utilize the space of the tunnel.

It should be understood that the shape of the metallic carrier base material, according to the present invention, is not limited to the exact details of construction shown in these figures.

The planar band material made of thin steel strip used in the present invention is fabricated from the heat-resistant steel plate materials and quenched foils, made of low carbon steel, containing carbon of less than 0.15 weight %, or of chrome steel, containing carbon of less than 0.15 weight % and chromium of less than 0.15 - 0.30 weight %, by fabricating the material through hot and cold rolling to reduce its thickness to about 0.30 - 0.1 mm.

After the thin band material is treated with a cleaning process and then with an activation process, nickel-plated layers each of 5 microns in thickness are formed on both the front and back surfaces of the band material by a normal electroplating procedure. The formation of this nickel-plated layer may be performed in the middle of the rolling process, and the thin band material may be rolled thereafter to obtain the material with the desired thickness.

The formation of the nickel-plated layer is very important because it aims to increase the heat-resistant

property of the metallic carrier base material, in conjunction with immersion processing in a molten aluminium bath (as described later), and to improve the bonding strength between the band materials themselves and between the metallic carrier base material and the metal case.

The corrugated band material used in the present invention is fabricated by passing the band material between forming gears.

The planar band material (1) and the corrugated band material (2) thus fabricated, are compiled alternately and wound up in spiral form, and a multi-layer body (5) having a number of screen-like vent holes (4) in axial direction is formed. The multi-layer body (5) may be fabricated by cutting the band materials (1) and (2) into a certain length and by piling them up alternately in stratified form, one on top of each other.

The multi-layer body (5) thus fabricated, is to be the metallic carrier base material for supporting the catalyst for exhaust gas purification. The multi-layer body (5), i.e. the metallic carrier base material for supporting the catalyst for exhaust gas purification, may be fixed by spot welding when necessary and may be housed in a cylindrical metal case (3) with open ends.

The multi-layer body (5) is treated with defatting and pickling processes in advance, and it is immersed into the molten aluminium bath of about 700 - 800°C, promptly after flux treatment. The duration of the immersion processing is usually up to about 60 seconds, but it may last beyond the limit of 60 seconds. After

taking it up from the bath, excessive aluminium may be removed from the multi-layer body (5) by air blasting, and then washed with hot water.

In the immersion process of the multi-layer body (5) in the molten aluminium bath, aluminium-coated layers are formed on the front and back surfaces of the band materials (1) and (2), which constitute the multi-layer body. At the same time, aluminium in the aluminium layer is diffused into the plating layer during the heating in the immersion process. Thus, a layer of intermetallic compound, i.e. a nickel-aluminium alloy layer, is formed.

The formation of this nickel-aluminium alloy layer is very important because it increases the heat-resistant property and the resistance to high temperature corrosion of the metallic carrier base material.

Further, when the multi-layer body (5) is treated by the immersion process in the molten aluminium bath, the contact portion between the multi-layer band materials (1) and (2) are firmly bonded together. It seems that such firm bonding of the contact portion is attained not only by the bonding between the aluminium layers themselves, formed on the surface of the band materials, but also by the bonding between the nickel-aluminium alloy layers formed by the immersion processing in the molten aluminium bath, and further, by the bonding between the nickel-aluminium-iron alloy layers effected by the alloying with iron in the band materials.

In the present invention, the nickel-aluminium alloy layer can be expanded or diffused through heating in a

non-oxidizing atmospheric gas, in a vacuum or in a salt bath - for example, by heating to about 700°C. Thus, the heat-resistant property of the metallic carrier base material can be increased.

Also, the band materials (1) and (2), treated with nickel plating in advance and then with aluminium plating, may be used for the manufacture of the metallic carrier base material for supporting the catalyst for exhaust gas purification according to this invention.

As described above, the metallic carrier base material to support the catalyst for exhaust gas purification according to this invention is manufactured by the immersion processing of the multi-layer body (5) in the molten aluminium bath. The immersion processing may be performed not only for the multi-layer body (5) itself, but also for the multi-layer body accommodated in the metal case (3). In such case, the interior of the metal case (3) may be treated with nickel plating in advance. Thus, the contact portions between the multi-layer body (5) and the metal case (3) will be firmly fixed together by the bonding between the aluminium layers themselves and between the nickel-aluminium alloy layers themselves.

In the following, the invention will be described in detail in conjunction with the examples, but it should be understood that the present invention is not limited to the exact details of such examples.

Example 1

On the front and back surfaces of the planer band material consisting of thin steel strips made of low carbon steel (JIS G3141 SPCC) of 0.05 mm in thickness and 74.5 mm in width, a nickel plating layer of 6 microns in thickness was formed by electro-plating. This planar band material was passed between forming gears to fabricate the corrugated band material with a pitch of 5.0 mm between crests in longitudinal direction and with a crest height of 2.5 mm. Both band materials thus fabricated were piled up one upon another, and were wound up in spiral form. By bonding the major points of the materials by spot welding, a multi-layer body of 70 mm in diameter, having a number of screen-like vent holes in axial direction, was formed.

This multi-layer body was treated with a defatting and pickling process and was further immersed in the mixed molten salt bath, consisting of lithium chloride, potassium chloride, sodium chloride and sodium fluoride, to perform flux processing. Then, it was immersed into the molten bath of aluminium at 720 °C for 15 seconds. Excessive aluminium was then removed by air blasting and then it was washed with hot water, and the metallic carrier base material having a heat-resistant and anti-corrosive coating layer was obtained.

Example 2

The planar band material, consisting of thin steel strips made of chrome steel (JIS G4305 SUS 401L) (Chromium 13%) of 0.04 mm in thickness and 38 mm in width was treated with the cleaning and activation process. Then, a nickel plating layer of 5 microns in thickness was formed on

both the front and back surfaces of the material by electroplating. The corrugated band material with a pitch of 3.5 mm between the crests in longitudinal direction and with a crest height of 1.8 mm was fabricated by passing this planar band material between the forming gears. By a procedure similar to that of the embodiment 1, a multi-layer body in spiral form was formed with these two materials. Further, the metallic carrier base material of multi-layer structure was placed in a cylindrical metal case of about 70 mm in inner diameter, made of nickel-plated iron material. By a procedure similar to that of the embodiment 1, the immersion process was performed in the molten aluminium bath for 12 seconds, and the metallic carrier base material having a heat-resistant and anti-corrosion coating layer on its surface was obtained.

The powder of activated alumina (gamma alumina) and the slurry with blended alumina sol were coated on the surface of the vent holes of the metallic carrier base material as obtained in the embodiment 1, and on the surface of the vent holes of the metallic carrier base material as obtained in the embodiment 2, and these were heated to 600°C, and the catalyst carrier layer was adhered to the surface of the vent holes of the metallic carrier base material. The specimens thus obtained were subjected to the test by performing 50 cycles of quick heating and quick cooling between normal temperature and 700°C and by applying vibration. As a result, neither cracking nor detachment were observed on the joining portion and the coated layer of the specimens. This test proved that the metallic carrier base material, according

to the invention, has excellent heat-resistant shockproof properties.

Since the band materials used in the metallic carrier base material of the present invention consist of steel strips of low carbon steel or chrome steel, the material can be easily rolled and is also available at relatively low cost.

On the surface of the nickel-plated band material of the metallic carrier base material of the present invention, aluminium is diffused and coated by the immersion process in the molten aluminium bath. At the same time, the alloy layer containing nickel such as the nickel-aluminium inter-metallic compound is formed in the middle, and the coating layer thus fabricated provides excellent heat-resistant properties and the resistance to high temperature corrosion. By these coated alloy layers, firm bonding is assured for the contact portion between the multi-layer band materials themselves or for the contact portion between the band material and the metal case. The welding or brazing process otherwise required can be eliminated.

CLAIMS

1. A method of manufacturing a metallic carrier base material of multi-layer structure for supporting a catalyst for exhaust gas purification wherein a multi-layer body is formed by compiling alternately, planar material and corrugated material so as to be in contact with each other, each made of thin nickel-plated steel strips, whereby vent holes are formed between the planar material and the corrugated material, and treating the multi-layer body by immersion in molten aluminium.

2. A method as claimed in claim 1 wherein the thin nickel-plated steel strips are made of low carbon steel or chrome steel.

3. A method as claimed in claim 2, wherein the low carbon steel includes carbon of up to 0.15 weight %.

4. A method as claimed in claim 3, wherein the chrome steel includes carbon of up to 0.15 weight % and chromium of up to 0.15 -0.30 weight %.

5. A method as claimed in any one of the preceding claims, wherein the thickness of the thin nickel-plated steel strip is about 0.30 to 0.1 mm.

6. A method as claimed in any one of the preceding claims, wherein the multi-layer body is wound up in a spiral form.

7. A method as claimed in any one of claims 1 to 5, wherein the multi-layer body is piled up in stratified form.

8. A method as claimed in any one of the preceding claims, wherein a contact portion is formed between the planar band material and the corrugated band material, said contact portion being bonded by spot welding.

9. A method as claimed in any one of the preceding claims, wherein the immersion in molten aluminium is performed at a temperature of 700 to 800°C.

10. A method as claimed in any one of the preceding claims, wherein the immersion is performed within about 60 seconds.

11. A method as claimed in any one of claims 1 to 8, wherein the immersion is performed within about 30 seconds at a temperature of about 720 - 760°C.

12. A method as claimed in any one of the preceding claims, wherein the multi-layer body is treated by immersion in a molten aluminium bath, and the excessive aluminium is thereafter removed by air blasting, and is thereafter washed with hot water.

13. A method as claimed in any one of the preceding claims wherein the metallic carrier base material of multi-layer structure is accommodated in a cylindrical metal case.

14. A method as claimed in claim 13, wherein the inner wall of the cylindrical metal case has been previously plated with nickel.

15. A method as claimed in any one of the preceding claims substantially as described hereinbefore with reference to any one of the Examples.

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